

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

- 1 1-7 (Canceled).
- 1 8. (Original) A computer-readable storage medium storing instructions that when executed by a computer cause the computer to perform a method for using a computer system to solve a system of nonlinear equations specified by a vector function, \mathbf{f} , wherein $\mathbf{f}(\mathbf{x}) = \mathbf{0}$ represents a set of nonlinear equations, $f_i(\mathbf{x}) = 0, f_2(\mathbf{x}) = 0, f_3(\mathbf{x}) = 0, \dots, f_n(\mathbf{x}) = 0$, wherein \mathbf{x} is a vector $(x_1, x_2, x_3, \dots, x_n)$, the method comprising:
 - 7 receiving a representation of a subbox $\mathbf{X} = (X_1, X_2, \dots, X_n)$, wherein for each dimension, i , the representation of X_i includes a first floating-point number, a_i , representing the left endpoint of X_i , and a second floating-point number, b_i , representing the right endpoint of X_i ;
 - 11 storing the representation in a computer memory;
 - 12 applying term consistency to the set of nonlinear equations, $f_1(\mathbf{x}) = 0, f_2(\mathbf{x}) = 0, f_3(\mathbf{x}) = 0, \dots, f_n(\mathbf{x}) = 0$, over \mathbf{X} , and excluding portions of \mathbf{X} that violate any of these nonlinear equations;
 - 15 applying box consistency to the set of nonlinear equations over \mathbf{X} , and excluding portions of \mathbf{X} that violate any of the nonlinear equations; and
 - 17 performing an interval Newton step on \mathbf{X} to produce a resulting subbox \mathbf{Y} , wherein the point of expansion of the interval Newton step is a point \mathbf{x} within \mathbf{X} ,

19 and wherein performing the interval Newton step involves evaluating $f(x)$ using
20 interval arithmetic to produce an interval result $f^I(x)$.

1 9. (Original) The computer-readable storage medium of claim 8, wherein
2 performing the interval Newton step involves:

3 computing $J(x,X)$, wherein $J(x,X)$ is the Jacobian of the function f
4 evaluated as a function of x over the subbox X ; and
5 determining if $J(x,X)$ is regular as a byproduct of solving for the subbox Y
6 that contains values of y that satisfy $M(x,X)(y-x) = r(x)$, where
7 $M(x,X) = BJ(x,X)$, $r(x) = -Bf(x)$, and B is an approximate inverse of the center of
8 $J(x,X)$.

1 10. (Original) The computer-readable storage medium of claim 9, wherein
2 the method further comprises:

3 applying term consistency to the preconditioned set of nonlinear equations
4 $Bf(x) = \mathbf{0}$ over the subbox X ; and
5 excluding portions of X that violate the preconditioned set of nonlinear
6 equations.

1 11. (Original) The computer-readable storage medium of claim 9, wherein
2 the method further comprises:

3 applying box consistency to the preconditioned set of nonlinear equations
4 $Bf(x) = \mathbf{0}$ over the subbox X ; and
5 excluding portions of X that violate the preconditioned set of nonlinear
6 equations.

1 12. (Original) The computer-readable storage medium of claim 8, wherein
2 applying term consistency to the set of nonlinear equations involves:

3 for each nonlinear equation $f_i(\mathbf{x}) = 0$ in the system of equations $\mathbf{f}(\mathbf{x}) = \mathbf{0}$,
4 symbolically manipulating $f_i(\mathbf{x})=0$ to solve for an invertible term, $g(x'_j)$, thereby
5 producing a modified equation $g(x'_j)=h(\mathbf{x})$, wherein $g(x'_j)$ can be analytically
6 inverted to produce an inverse function $g^{-1}(\mathbf{y})$;
7 substituting the subbox \mathbf{X} into the modified equation to produce the
8 equation $g(X'_j) = h(\mathbf{X})$;
9 solving for $X'_j = g^{-1}(h(\mathbf{X}))$; and
10 intersecting X'_j with the vector element X_j to produce a new subbox \mathbf{X}^+ ;
11 wherein the new subbox \mathbf{X}^+ contains all solutions of the system of
12 equations $\mathbf{f}(\mathbf{x}) = \mathbf{0}$ within the subbox \mathbf{X} , and wherein the width of the new subbox
13 \mathbf{X}^+ is less than or equal to the width of the subbox \mathbf{X} .

1 13. (Original) The computer-readable storage medium of claim 8, wherein
2 the method further comprises:
3 evaluating a first termination condition, wherein the first termination
4 condition is TRUE if,
5 zero is contained within $\mathbf{f}^1(\mathbf{x})$,
6 $\mathbf{J}(\mathbf{x},\mathbf{X})$ is regular, wherein $\mathbf{J}(\mathbf{x},\mathbf{X})$ is the Jacobian of the
7 function \mathbf{f} evaluated as a function of \mathbf{x} over the subbox \mathbf{X} , and
8 the solution \mathbf{Y} of $\mathbf{M}(\mathbf{x},\mathbf{X})(\mathbf{y}-\mathbf{x}) = \mathbf{r}$ contains \mathbf{X} ; and
9 if the first termination condition is TRUE, terminating and recording \mathbf{X} as
10 a final bound.

1 14. (Original) The computer-readable storage medium of claim 13,
2 wherein the method further comprises:
3 evaluating a second termination condition;

4 wherein the second termination condition is TRUE if a function of the
5 width of the subbox **X** is less than a pre-specified value, ε_X , and the width of the
6 function **f** over the subbox **X** is less than a pre-specified value, ε_F ; and
7 if the second termination condition is TRUE, terminating and recording **X**
8 as a final bound.

1 15-21 (Canceled).